

CLAIMS

[1] An actuator using a fluid cylinder, comprising:

a fluid cylinder having a cylinder chamber and a piston slidably disposed in the cylinder chamber so as to partition the cylinder chamber into a first chamber and a second chamber;

a first choke valve device disposed between a fluid pressure source and the first chamber to adjust a fluid pressure in the first chamber; and

a second choke valve device disposed between the fluid pressure source and the second chamber to adjust a fluid pressure in the second chamber,

each of the first choke valve device and the second choke valve device including a supply valve mechanism that permits the fluid to flow in the input direction from the fluid pressure source to the corresponding chamber and a discharge valve mechanism that permits the fluid to flow in the output direction from the chamber to the fluid pressure source, and

wherein at least the discharge valve mechanism being capable of varying the opening of the valve.

[2] The actuator using a fluid cylinder according to claim 1, wherein the supply valve mechanism and the discharge valve mechanism are provided separately from each other.

[3] The actuator using a fluid cylinder according to claim 2, wherein the discharge valve mechanism comprises:

a continuously variable actuator capable of continuously varying the position of the valve;

valve position detecting means for detecting the position of the valve; and

control means for feedback controlling the continuously variable actuator based on an output of the valve position detecting means.

[4] The actuator using a fluid cylinder according to claim 2, wherein the discharge valve mechanism comprises:

a plurality of different type of open/close valves connected in parallel to each other, each of which has a discharge flow path with a different cross sectional area respectively; and

valve selection control means for, selecting at least one or more open/close valves from the plurality of different type of open/close valves and controlling to open the at least one or more open/close valves which have been selected.

[5] The actuator using a fluid cylinder according to claim 1, wherein both of the supply valve mechanism and the discharge valve mechanism are constructed within a hybrid valve mechanism that comprises:

a valve seat block that has a discharge path with a constant width and a supply path with gradually varying width, the discharge path and the supply path being arranged side by side;

a valve plug that includes a flow path and a large flow path formed continuously with the flow path and having a cross sectional area larger than that of the flow path, and is arranged slidably with respect to the valve seat block; the position thereof being controlled, in supplying operation, to fully open the supply path and to completely close the discharge path, and in discharging operation, to completely close the supply path and to have the flow path communicated with the discharge path so that the communication area between the discharge path and the flow path can be continuously varied; and

a stationary block that has a small flow path with a cross sectional area smaller than that of the large flow path constantly communicated with the large flow path irrespective of the position of the valve plug.

[6] The actuator using a fluid cylinder according to claim 1, wherein both of the supply valve mechanism and the discharge valve mechanism are constructed within a hybrid valve mechanism that comprises a pressure control valve mechanism; a one-way valve mechanism that permits the fluid to flow only in the input direction from the fluid pressure

source to the corresponding chamber side through the pressure control valve mechanism; and a two-way valve mechanism that permits the fluid to flow in the two directions; i.e., in the input direction from the fluid pressure source to the chamber through the pressure control valve mechanism and in the output direction from the chamber to the fluid pressure source; and

wherein the two-way valve mechanism is arranged so that the opening of the valve can be varied depending on the pressure of the fluid supplied from the fluid pressure source.

[7] The actuator using a fluid cylinder according to claim 6, wherein the two-way valve mechanism comprises:

a rod equipped with a moving needle;

a restriction member that has a through hole through which the moving needle movably penetrates and with which the flow rate of the fluid passing through the through hole is controlled depending on the position of the moving needle;

a spring member that constantly applies an energizing force to the rod for shifting the moving needle in the direction that the fluid passing through the through hole increases; and

a fluid-driven rod shifting mechanism that causes the rod to shift against the energizing force of the spring

member by means of a pressure of the fluid supplied from the fluid pressure source to shift the moving needle in the direction that the flow rate of the fluid passing through the through hole of the restriction member decreases.

[8] The actuator using a fluid cylinder according to claim 7, wherein each of the first and second choke valve devices includes:

a device body having a first connection port connected to the corresponding chamber, a second connection port, which is connected to the fluid pressure source and an inner flow path positioned between the first connection port and the second connection port through which the fluid flows, and

a spring member mounting structure for mounting the spring member to the device body,

wherein the restriction member and a part of the rod equipped with the moving needle are disposed within the inner flow path of the device body, and

wherein, a valve of the one-way valve mechanism is provided to a peripheral portion of the restriction member, the valve being positioned between an inner wall portion of the device body enclosing the inner flow path and the peripheral portion and operating by means of the inner wall portion as the valve seat.

[9] The actuator using a fluid cylinder according to claim 8, wherein, the fluid-driven rod shifting mechanism comprises a cylinder section communicated with the inner flow path formed within the device body and a piston section provided to the rod, the piston section sliding in the cylinder section, and

wherein the spring member mounting structure is structured so that the energizing force of the spring member works on the outer portion of the rod extending from the cylinder section.

[10] The actuator using a fluid cylinder according to claim 9, wherein the second connecting port is disposed so as to be communicated with the flow path positioned between the restriction member and the cylinder section.

[11] The actuator using a fluid cylinder according to claim 8, wherein the spring member is comprised of a coil spring member disposed in a compressed state and has the internal end at the device body side and the external end at the external end side of the rod, and

wherein the spring member mounting structure includes a cylindrical member that is positioned inside the coil spring member and fixed to the outer portion of the rod and moves along with the rod, and is the cylindrical member being provided with an engaging portion to be engaged

with the internal end of the coil spring member, and a spring member intermediate portion holding structure that is positioned at the outer side of the cylindrical member, and is arranged so as not to shift with respect to the device body and so as to hold an intermediate portion of the coil spring member, and

wherein the spring member intermediate portion holding structure is constructed in such a manner that the number of turns within a section in the coil spring member which is held between the engaging portion and the structure can be changed by varying the holding position of the intermediate portion of the coil spring member, the section of the coil spring member acting as a compressed spring.

[12] The actuator using a fluid cylinder according to claim 11, wherein the spring member intermediate portion holding structure has a wedge member inserted between neighboring two turn portions of the coil spring member, and

the wedge member is disposed so as to allow the coil spring member to be rotated on the cylindrical member.

[13] A control method of an actuator using a fluid cylinder set forth in claim 1, wherein, when the position of the piston in the fluid cylinder is shifted by positively supplying the fluid through one of the first and second choke valve devices from the fluid pressure source into the

cylinder chamber, the flow rate of the fluid toward the output direction of the two-way-valve mechanism in the discharge valve mechanism of each of the first and second choke valve devices is restricted and thereby the mobility of the piston of the fluid cylinder due to the external force or the stiffness of the fluid cylinder is determined.

[14] A control method of an actuator using a fluid cylinder set forth in claim 6, wherein, when the position of the piston in the fluid cylinder is shifted by positively supplying the fluid through one of the first and second choke valve devices from the fluid pressure source into the cylinder chamber, the flow rate of the fluid toward the output direction of the two-way-valve mechanism in the discharge valve mechanism of each of the first and second choke valve devices is restricted and thereby the mobility of the piston of the fluid cylinder due to the external force or the stiffness of the fluied cylinder is determined.

[15] A control method of an actuator using a fluid cylinder set forth in claim 14, wherein the fluid is positively supplied from the fluid pressure source to the choke valve device to shift the piston section provided to the rod to positively close the through hole of the restriction member with the moving needle, thereby the piston of the fluid cylinder is stopped.

[16] A choke valve device suitable for being used as a first choke valve device or a second choke valve device of an actuator comprising a fluid cylinder that has a cylinder chamber and a piston disposed slidably in the cylinder chamber so as to partition the cylinder chamber into a first chamber and a second chamber,

the first choke valve device disposed between a fluid pressure source and the first chamber for adjusting the fluid pressure within the first chamber; and

the second choke valve device disposed between the fluid pressure source and the second chamber for adjusting the fluid pressure within the first chamber comprises;

a one-way valve mechanism that permits the fluid to flow only in the input direction from the fluid pressure source to the corresponding chamber side, and

a two-way valve mechanism that permits the fluid to flow in the two directions; i.e., in the input direction from the fluid pressure source to the chamber and in the output direction from the chamber to the fluid pressure source side,

wherein the two-way valve mechanism comprises:

a rod equipped with a moving needle;

a restriction member that has a through hole through which the moving needle movably penetrates, and with which the flow rate of the fluid passing through the through hole

is controlled depending on the position of the moving needle;

a spring member that constantly applies an energizing force to the rod for shifting the moving needle in the direction that the fluid passing through the through hole increases;

a fluid-driven rod shifting mechanism that causes the rod to shift against the energizing force of the spring member by means of the pressure of the fluid supplied from the fluid pressure source to shift the moving needle in the direction that the flow rate of the fluid passing through the through hole of the restriction member decreases; and

a spring member mounting structure capable of adjusting the number of turns within a section in the spring member which functions as a compressed spring.